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PUBLIC SERVICE COMMISSION OF WISCONSIN

Report to the Legislature's
Joint Committee on Information
Policy and Technology

Status of Investments in Advanced Telecommunications Infrastructure in Wisconsin

05-ST-112

PUBLIC SERVICE COMMISSION OF WISCONSIN

Status of Investments in Advanced Telecommunications Infrastructure in Wisconsin

Docket 05-ST-112

Year 2000

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To the Reader:

This infrastructure report fulfills the requirements of Wis. Stat. § 196.196(5)(f). The report includes text, graphs, and maps that document investments in advanced telecommunications infrastructure. As mandated, the report specifically contains information on the progress made in the areas of distance learning, libraries, health care, opportunities for persons with disabilities and other persons in the home, and the deployment of Integrated Services Digital Network (ISDN).

The appendix of the report contains Geographic Information Systems (GIS) maps showing geographic locations of specific infrastructure elements and services.

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Part
A

Forward

February 2002

To the Joint Committee on Information Policy and Technology:

We are pleased to send you the Public Service Commission's fourth biennial report on telecommunications infrastructure in Wisconsin as required by Wis. Stat. § 196.196(5)(f). The report includes text and maps documenting the progress of investments in advanced telecommunications infrastructure. As mandated, the report specifically contains information on the advancements made in distance learning, library services, health care, opportunities for persons with disabilities and other persons in the home, and deployment of Integrated Services Digital Network (ISDN).

The appendix of the report contains Geographic Information Systems (GIS) maps, which show the geographic location of various infrastructure elements and services in the state.

Sincerely,

Ave M. Bie *Joseph P. Mettner* *Robert M. Garvin*

Ave M. Bie
Chairperson

Joseph P. Mettner
Commissioner

Robert M. Garvin
Commissioner

Part
B

Executive Summary

The Public Service Commission (Commission) has prepared this fourth biennial report for the legislature as required under Wis. Stat. § 196.196(5)(f). This report contains updated information about the use of advanced telecommunications infrastructure for distance learning, the interconnection of libraries, and access to health care. The report also presents information on incumbent and competitive companies' investments in infrastructure and offerings of services such as Integrated Services Digital Network (ISDN) and Digital Subscriber Line (DSL). Maps, located in the appendix, illustrate the status of many infrastructure parameters and provide a visual comparison of the status of infrastructure for 1998 and 2000.

There have been incremental increases in the use of advanced telecommunications for distance learning, the interconnection of libraries, access to health care, and assistance to persons with disabilities. The use of ISDN has also grown modestly. The principal improvements in these areas relate to access to the Internet and the continued growth in the number of libraries with high-speed dedicated access.

Infrastructure investments by the Incumbent Local Exchange Carriers (ILECs) continue to grow at a steady pace. DSL deployment by both the ILECs and Competitive Local Exchange Carriers (CLECs) showed significant gains. Although the number of certified CLECs increased from 50 in 1999 to over 100 in 2000, the number of CLECs actually providing service was under one quarter of those certified. The CLEC's investment in infrastructure has trended downward over the past 18 months amidst mergers and reorganizations.

Although over 100 CLECs in Wisconsin are certified to provide service, under one quarter of those certified were actually providing service to customers at year end 2000.

Cable and wireless companies have maintained a role as viable competitors to the wire line providers, with high-speed connection to the Internet continuing to be a growth driver for these entities.

Distance Learning

The availability of the Technology for Educational Achievement in Wisconsin (TEACH) program and Federal E rate funds provided by the Federal Communications Commission (FCC) has aided the further growth of Wisconsin's distance education networks. The growth includes K-12 school networks, along with full motion video sites in technical colleges and private colleges.

Technology changes have limited growth of the networks that use older, J Series Compressor Decompressors (CODECs) that are no longer manufactured. The Wisconsin Department of Electronic Government (DEG) is investigating the options available for converting to a different video standard.

Access to Health Care

There are ongoing programs that use telecommunications networks for clinical purposes. These include the telemedicine programs of the Veterans Administration (VA), the Marshfield Clinic, and the Wisconsin Department of Corrections (DOC). The Milwaukee VA is using tele-pathology to provide continuing education in microbiology and infectious diseases to medical personnel at the outlying hospitals. In addition, the telemedicine network between Milwaukee and Iron Mountain, Michigan has expanded to include tele-pathology and tele-radiology applications.

Infrastructure Deployment

ILECs have shown a steady increase in the deployment of infrastructure including switching, outside plant, and advanced services. ILECs have deployed broadband services such as DSL service, a potential competitor to ISDN. DSL uses existing copper wires and special equipment to provide a high-speed connection that can be used in place of other higher priced broadband services such as Switched 56. Cost effective and flexible Synchronous Optical NETwork (SONET) facilities that ride on the fiber cable also have shown increased deployment.

CLECs in Wisconsin continue to evolve. Although a large number of CLECs are certified in this state, less than one quarter of those certified actually offered service to customers at year end 2000. The majority of the serving CLECs have their own switching facilities and most offer some type of data service. One of the fastest growing services for landline carriers is high-speed connections to the Internet.

Wireless and cable providers are increasingly competitive in providing customers high-speed access to the Internet. The demand for high-speed connections to the Internet continues to drive growth in infrastructure.

Typically, residential customers in Wisconsin have their homes wired for cable television; this gives the cable companies an advantage in providing broadband services. Industry experts expect cable modems to lead the broadband connections race, with DSL technologies following close behind. Businesses are less likely to be wired for cable; however, cable companies are making inroads to this market sector by providing cabling specifically aimed at access for high-speed data transmission.

Wireless technology is continuing to improve and evolve. The advantage of wireless technology is rapid deployment and configuration, because the cost of buying and installing wires and cables is avoided. Although wireless technology is still facing bandwidth limitations, there are increasing opportunities for wireless in the high-speed access market.

Recommendations and Conclusions

The information that the Commission has gathered indicates that ILECs continue to make steady progress in infrastructure investments. CLECs continue to change dynamically in the present economic environment and these companies offer a variety of technologies to Wisconsin consumers.

Rollout of DSL service by the ILECs and CLECs in the state is used an as indicator of broadband deployment. A company's deployment of broadband type service is an economic, not a technical issue. No one technology is recommended over another. However, broadband deployment will continue to be monitored and included as an infrastructure incentive for companies that choose to establish alternative regulation plans.

To assist in the continued monitoring of service and technology changes, the Commission recommends that companies continue to report information to the Commission through annual reports and data requests, and that CLEC reporting formats be further standardized to provide comparable information. The competitive companies should also be required to file information on service areas and services offered as public information to allow a more complete picture of changes in the infrastructure and the competitive marketplace.

Further, the Commission recommends that statutory authority (see Wis. Stat. § 196.25) be provided to allow the Commission to collect data from cable and wireless providers, so that the legislature and the public have relevant information about all facets of the telecommunications industry. The Commission should also have the ability to directly impose penalties or other consequences on companies that fail to respond to data requests or that file incomplete reports.

Part
1

Introduction

This report is divided into six sections.

Part 1 provides the report introduction and general information.

Part 2 focuses on the progress in the use of advanced telecommunications infrastructure for designated purposes, such as schools, libraries, healthcare, and persons with disabilities.

Part 3 describes the progress of the deployment of infrastructure for advanced telecommunications services for the ILECs and the CLECs. There are brief comments on cable TV providers and wireless providers at the end of the section.

Part 4 summarizes conclusions and makes recommendations.

Part 5 is the Appendix of the report and includes a number of GIS maps that depict the location of various infrastructure items in the state.

Part 6 is a list of acronyms.

General Comments on the Report

This fourth infrastructure report generally reflects a year-end 2000 update of the information provided in previous infrastructure reports.[1] All previous reports are on file in the Commission Resource Center.

The information in Part 2 regarding the use of advanced infrastructure for designated purposes was gathered from discussions with providers and users, information provided via e-mail from providers and users, and from related sites on the World Wide Web.

[1] In some instances reported data is even more recent than year-end 2000; these are so identified.

The majority of information for Part 3 was compiled from two sources: 1) the year 2000 annual reports filed with the Commission by the ILECs and CLECs; and, 2) the year end 2000 infrastructure data request sent to both ILEC and CLEC providers. Unlike with the replies to earlier data requests, only a minimal amount of the filed data was submitted with a request for confidentiality. Only four providers (all CLECs) filed for confidential treatment of the infrastructure data. Information was also obtained from another Commission project that is studying the extent of competition in the state. Although this information will be summarized in a separate competitive study report, portions of the response data from that effort were used in this report to create maps and graphs related to CLEC services.

The data requested from the providers was for year-end 2000. All 83 ILECs in the state responded to the survey. Although 94 CLECs responded to the data request, only 25 companies were providing service at year end 2000.

Data sources and date references are indicated for the graphs, tables, and maps that are used throughout this report. The information from the annual reports and the year 2000 data requests mentioned above were used throughout the report to update the 1998 information from the previous report and further analyze the filed information.[2] The majority of the maps reflect 1998 data and 2000 data. Note that data filed confidentially in 1998, but filed non-confidentially in 2000, were added to the year 2000 database of information. The maps also reflect company-provided corrections to the 1998 filed data.

[2] Commission staff estimated a three to four percent error in the data presented.

Part
2

Use of Advanced Infrastructure for Designated Purposes

This section of the report provides information on the use of advanced telecommunications infrastructure for distance learning, interconnection of libraries, access to health care, assistance to persons with disabilities, and to some extent, the deployment of Integrated Services Digital Network (ISDN), as required by Wis. Stat. § 196.196(5)(f)(1). This year's report should be viewed in conjunction with the 1999 report because there have not been significant increases in the use of advanced infrastructure for the listed purposes, and the observations in that earlier report remain fairly current.

Since the 1999 report, there have been what can only be described as incremental advances in the use of advanced telecommunications infrastructure for distance learning, interconnection of libraries, access to health care, assistance to persons with disabilities, and in the use of ISDN. Between the consolidation of smaller networks and the creation of new networks, the number of K-12 distance education networks that use two-way full motion video remains about the same. In some networks, more schools were added to the networks; in other instances, additional distance education classes were offered and student enrollments increased. Nearly all Wisconsin libraries have access to the Internet; the main improvement since the 1999 report has been the continued growth in libraries with high-speed dedicated access. In health care, there has been increased use of existing high-capacity networks between hospitals and clinics, but no new dedicated tele-health networks were installed. The emphasis in improving access to persons with disabilities has been to improve access to computers, web pages, and Internet connections. ISDN has become a niche service with most of the investment in new technology for advanced services focused on the provision of broadband services through DSL technology or through the use of cable modems by the cable television industry.

Distance Learning, Including the Number of Schools and Other Educational Institutions Connected to Distance Learning Networks

The procurement of advanced telecommunications services to facilitate distance education in Wisconsin continues to grow as a result of the subsidized services obtained through the TEACH program and the "E-rate" funds provided by the FCC. These programs have made it possible for the number of K-12 schools connected to two-way distance education networks to increase from 245 in 1999 to approximately 270 at the end of 2001.

Information taken from the web page of the Wisconsin Association of Distance Education Networks (WADEN)[3] suggests that about 25 percent more distance education courses have been offered in the 2001-2002 school year.

The number of sites using two-way, full motion advanced telecommunications to provide college courses has grown from 75 in 1999 to 102 in 2001. Most of this growth has occurred in the technical college system by adding additional sites to existing networks. Most K-12 networks include links to technical colleges and access to university networks for programming. These connections have made it possible for high school students to earn college credits through distance education. Cooperative Educational Services Agency (CESA) 10 reported that more than half of its students enrolled in distance education classes were taking university or technical college courses. The number of private colleges in distance education networks continues to grow, increasing from five in 1999 to ten currently.

Most of the high-speed distance education networks use DS-3 signals over fiber optics with the J-series CODECs for converting between digital and analog video signals. These networks are now facing a limit to their growth because the J-series CODECs are no longer manufactured. Apparently the inventory is sufficient for existing needs for the near future, but is not adequate to add additional sites. The cost to change technology will also limit the resources available to add more schools. The Wisconsin DEG is investigating the options available for converting to a different video standard. Because networks are becoming more integrated, the conversion will need to be closely coordinated. With additional video gateways, it has become easier to share programming between networks that use either analog video or digital Moving Picture Experts Group[4] (MPEG) technology provided by cable television companies and the bulk of the schools in DS-3 based networks provided by telephone companies.

Interconnection of Libraries Including the Number of Libraries with Video Conferencing and Network Access Capabilities

The 1999 report noted that 92 percent of the 381 public libraries in Wisconsin were able to use the Internet, with the number having direct access approaching 70 percent. Marginal increases from these already high levels are all that could be expected, and by July of 2001, 98 percent of all public libraries had access to the Internet, with 78 percent able to obtain direct access, primarily through the use of TEACH subsidized T1 lines.[5]

Wisconsin's public libraries continue to make use of the telecommunications infrastructure to share automated circulation systems. By 2001, 81 percent of public libraries had automated their circulation systems with 61 percent of these libraries able to share this information electronically. A more comprehensive analysis of shared circulation systems can be found in ELIZABETH BURMASTER, WISCONSIN

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[3] http://www.uwex.edu/disted/waden/networks/index.html.
[4] Digital compression standard.
[5] From the Department of Public Instruction web page at http://www.dpi.state.wi.us/dpi/dlcl/pld/netauto.html.

DEP'T OF PUBLIC INSTRUCTION, STATE SUPERINTENDENT'S REPORT ON INTERLIBRARY COOPERATION AND RESOURCE SHARING 1999-2003 (2001).[6]

Access to Health Care

The ongoing programs in Wisconsin actively using telecommunications networks for clinical purposes are the VA network, the Marshfield Clinic Network, and the Wisconsin DOC. There have been no significant changes in these networks since the last report in 1999, although usage of the existing networks has increased.

An example of this increased usage is the Veterans Administration's telemedicine activities that started with a connection between Milwaukee and Iron Mountain, Michigan and is used to transmit medical images to Milwaukee for pathology analysis. The VA Hospital has used this connection to read over 4,500 cases by tele-pathology in the past four years. This network is the most extensive one used for tele-pathology in the United States. The network has expanded to include units at the Tomah and Madison VA hospitals and four VA hospitals in the Chicago area. Tele-pathology is also a key tool used to provide continuing education on microbiology and infectious diseases from the Milwaukee VA to medical personnel at the outlying hospitals.

The telemedicine network between Milwaukee and Iron Mountain has expanded to other services, including the following:

1) tele-pathology, used by the Milwaukee VA for all routine surgical and frozen section cases at Iron Mountain;

2) tele-radiology, used for plain film, fluoroscopic images, and cat scan (CT) interpretation of cases;

3) tele-psychiatry, used for out-patient care provided to the Iron Mountain VA and for veterans at a satellite clinic in Appleton, Wisconsin. In 2000, 698 outpatient visits were logged by tele-psychiatry;

4) the tele-pulmonary clinic provides outpatient pulmonary care. In 2000, 99 patient visits were conducted by the Milwaukee VA physicians via telemedicine;

5) the tele-rheumatology clinic provides outpatient rheumatology care. In 2000, 71 patient visits were conducted by the Milwaukee VA physicians via telemedicine;

6) the tele-endocrinology clinic provides outpatient endocrine care. In 2000, 53 patient visits were conducted by Milwaukee VA physicians via telemedicine.

[6]This report can be accessed at http://www.dpi.state.wi.us/dltcl/rll/pdf/report9903.pdf.

7) The tele-infectious diseases clinic provides outpatient care for HIV positive (mostly AIDS) patients. In 2000, 21 patient visits were conducted by the Milwaukee VA physicians via telemedicine.

In addition, there are new programs that use telecommunications to assist in the care of VA patients in their homes in the Milwaukee area. These programs include tele-home care and a tele-spinal cord injury program.

Education, Health Care, and Employment Opportunities for Persons with Disabilities and Other Persons in the Home

As noted in the introduction, the emphasis in improving access to persons with disabilities has been to improve access to computers, web pages, and Internet connections. The Commission is not aware of any additional changes in these of advanced telecommunications since the last report to assist persons with disabilities in gaining access to education, health care, or employment.

Part
3

Infrastructure Deployment

This section of the report reviews the status of telecommunications infrastructure in Wisconsin and updates the 1998 information that was documented in the previous report. The infrastructure deployment, unless otherwise noted, is generally reported based on the percentage of exchanges or wire centers that have a particular component of infrastructure in service. The related GIS maps, in Part 5, present a geographic picture of the deployment of infrastructure in the state.

This section begins with a summary of ILEC infrastructure information, followed by CLEC infrastructure information. Brief comparisons and comments on cable providers and wireless providers are included at the end of this section.

The infrastructure deployment is documented in most cases at the exchange level or wire center level. The exchange is a geographical area defined by the incumbent company; exchange boundary maps are on file at the Commission. All customers within an exchange area have access to the same ILEC services and pay the same amount for these services. The ILEC data request focused on the exchange level for ease of utility reporting. Information was collected for 603 ILEC exchanges. A wire center may be a subset of an exchange, although, for most of the exchanges in the state, the wire center and exchange are synonymous. Larger exchanges may be made up of two or more wire centers. These larger exchanges, such as Milwaukee, have multiple wire centers within the exchange and can further have multiple switches within an individual wire center. The ILEC annual report collects information by wire center. Data on 688 wire centers is reported in the year 2000 annual reports filed with the Commission. CLEC annual report data is reported by rate center. A rate center is similar to an exchange, in that it refers to the geographical area where the company provides services.[7] CLECs normally report their rate centers using ILEC exchange area or wire center designations when this information is available.

Incumbent Local Exchange Carrier Facilities

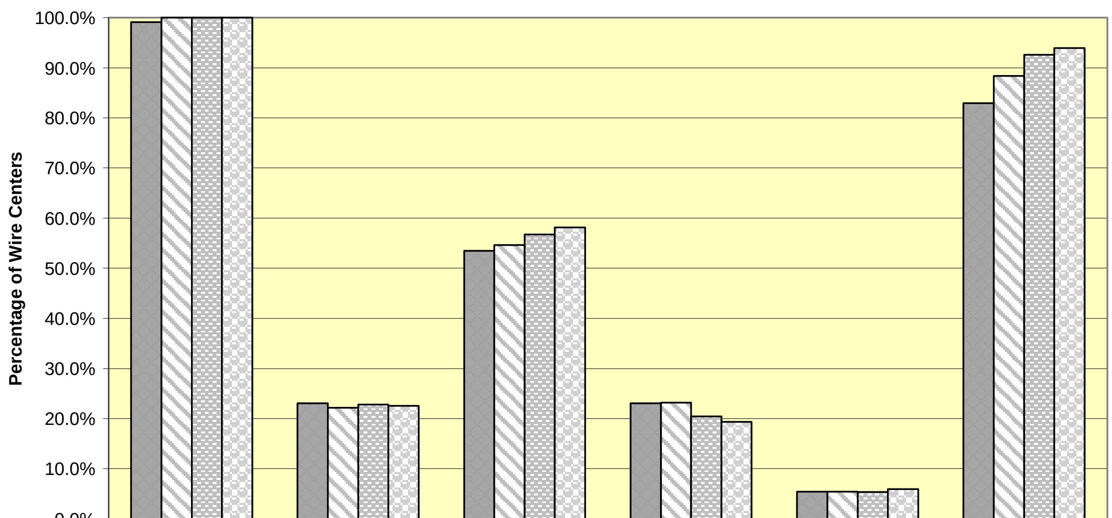
ILEC information is divided into three sections: switching, outside plant, and advanced services. This is similar to the format of past reports although the graphs and tables have been updated in this report to show additional items or to combine related data filed in the 2000 data request. The GIS maps reflect the 1998 status of infrastructure items with the year 2000 updated information indicated separately.

[7] In Wisconsin, the only instance where an ILEC exchange and ILEC rate center differ is the Milwaukee exchange. There are five rate centers that comprise the Milwaukee exchange.

The map data for 2000 indicates any corrections to 1998 data that were made by the companies in their recent filings.

Switching. Switching functions establish a connection path between the calling and called parties and disconnect the path when the call is complete. Most current switching functions are completed via digital switching using binary encoded information. Digital switching has replaced, for the most part, analog or circuit type switching. Wisconsin has had 100 percent digital switching since 1998. Graph 1 shows information on various switching parameters for years 1997 through 2000.

Switching Functions
For Incumbent Local Exchange Companies



	DIGITAL SWITCH	HOST SWITCH	REMOTE	STAND ALONE	PACKET	SS7 FUNCTION
1997	99.1%	23.1%	53.4%	23.1%	5.4%	82.9%
1998	100.0%	22.2%	54.7%	23.2%	5.4%	88.3%
1999	100.00%	22.79%	56.75%	20.46%	5.4%	92.60%
2000	100.00%	22.53%	58.14%	19.33%	6.0%	93.90%

1997 1998 1999 2000

December 2001 Graph 1 Source: ILEC PSC Annual Reports

Switching facilities can be deployed as host, remote, or stand-alone switches. Host switches are equipped with a common processor that is used to serve customers connected directly to the host switch and to provide certain functions to smaller switches located remotely (remote switches). Remote switches serve areas that are geographically separate from the host switch and connect calls between customers served from the same remote switch. The remote switches derive additional functionality, service features, and connectivity to other networks from the host switch. Stand-alone switches function independently and do not serve remote switches. Graph 1 shows there has been some decline in stand-alone switches, while remote switches have increased slightly. Companies may be changing out stand-alone switches for more economical host-remote type switch arrangements. Further comments on changes in switching arrangements are noted in reference to digital loop carrier (DLC), which is described under the advanced services section.

Most new digital switches are designed modularly and can meet a company's changing needs quickly and efficiently. All or portions of the switch may be upgraded as the need arises. The next generation of switches will more than likely be of a packet-switch architecture.

Packet-type switches are designed to carry data in the form of packets of digital information and are designed to transfer large amounts of data quickly and efficiently. Each packet is given a unique address and because the packets are independent of each other, they can take different routes in the network from originating to destination packet switch. The packets may arrive in a different order than they were presented to the network before they are reassembled at the destination based on their unique address. Packet switching is mainly used for transferring large amounts of data; however packet voice applications are improving. Graph 1 indicates only a minor change in the number of packet switches. At year end 1998, there were 37 packet switches;[8] this increased to 41 in year 2000. Map 1 indicates the geographical location of packet switches in the state.

Signaling System Seven (SS7) is the final switching function indicated on Graph 1. All phone systems use signaling. The signaling function is used to monitor a circuit to see if it is busy or free and set up the call, to signal the arrival of a call (that is the phone rings), and to transmit and route the signal over the network. SS7 signaling take place "out of band," which means the call-setup uses a different path through the network than the voice traffic. This frees up capacity on a facility. SS7 also provides connections to customer information databases that can provide new services or better administer call processing. For example, SS7 can alert the called party who is calling (Caller ID) by number and can also include, in some cases, the name of the calling party. SS7 is used by switches from different providers to communicate with each other in a common language and provides advanced network capabilities such as call forwarding, call waiting, and call transfer.

Graph 1 indicates that close to 94 percent of the existing switches are equipped with SS7, a moderate increase over 1998. As noted in previous reports, the upgrade to SS7 can represent a significant investment to companies depending on the type and age of the existing switch. Approximately 40 exchanges did not have SS7 deployed at year end 2000. ILECs have made commitments to upgrade all but eight of the exchanges by 2002. The majority of the companies making these SS7 deployment commitments are under price regulation or alternative regulation plans. Map 2 shows the geographic deployment of SS7.

Outside Plant. Outside plant traditionally refers to the part of the network that is physically located outside of the central office building. Outside plant includes the local loops from an ILEC's switch to the customer premises and the facilities that interconnect the various providers' switches. Outside plant facilities include fiber and copper cables, electronic equipment, and other types of line enhancing equipment. Traditional copper facilities have been replaced by fiber cables in various areas of the outside plant design, such as interoffice facilities and feeder facilities. Fiber optic technology provides

[8] For a number of exchanges, the availability of packet switches was reported incorrectly in 1997 through 1999. The data was corrected in 2000.

for higher capacity and bandwidth than traditional copper plant and is used to transmit advanced digital service and high-speed data. The advantages of fiber cable include improved security, lower cable weight for construction and handling, and easier splicing. Fiber also eliminates electromagnetic influence which can cause noise on a line.

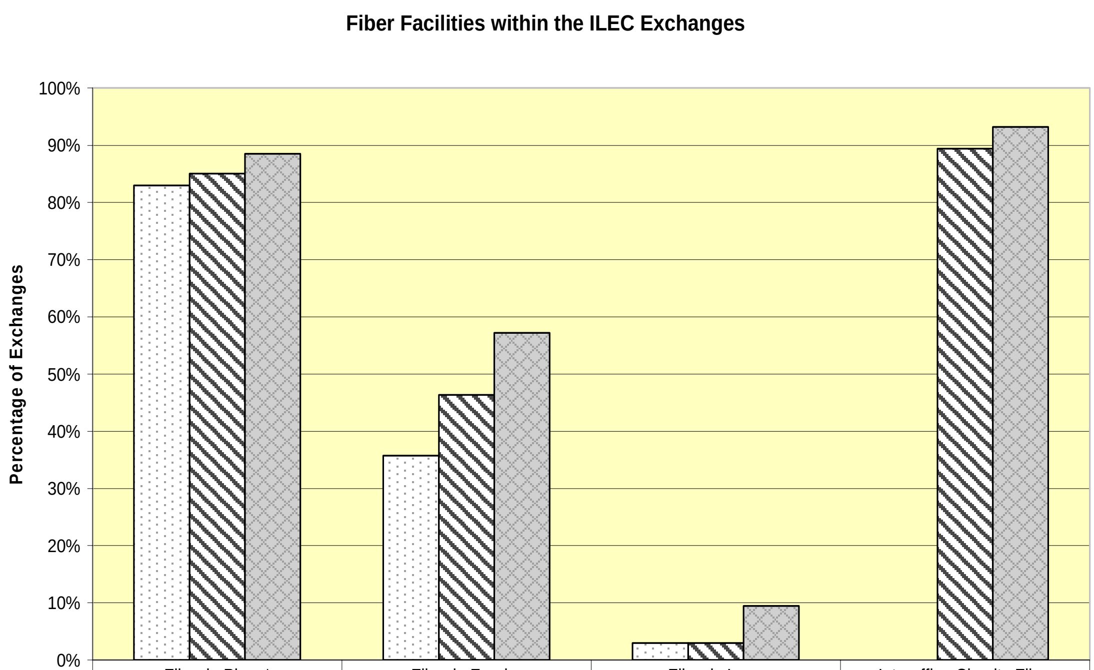
The mileage of installed fiber has grown steadily; for year-end 2000, the total reported mileage is 14,133 miles. Table A shows the progress of fiber deployment as measured by sheath miles. Table A also shows the percentages of wire centers that reported some fiber in the outside plant.

ILEC Fiber Deployment

Year	Total Fiber Miles in Place	Percentage of Wire Centers With Fiber
1996	9,889	83%
1998	12,093	85%
2000	14,133	88.5%

December 2001 Table A Source: ILEC PSC Annual Reports

Fiber facilities are installed for a number of applications. Graph 2 shows the growth in fiber use for ILEC exchanges in Wisconsin.



	Fiber in Place*	Fiber in Feeder	Fiber in Loop	Interoffice Circuits Fiber
1996	83%	36%	3%	
1998	85.0%	46.3%	3.0%	89.4%
2000	88.5%	57.2%	9.5%	93.2%

* Indicates Percentage of Wire Centers From the Annual Report

December 2001 Graph 2 Source: ILEC PSC Data Requests

Feeder fiber is defined for this report as a fiber facility originating in the central office and terminating at an intermediate distribution point such as a digital serving area (DSA). A DSA groups large clusters of subscribers and routes their calls to a central point in the exchange plant. DLC is often installed at this point and the calls are then transferred from an analog to a digital format and are routed over fiber cable back to the central office. This DSA design can be advantageous for providing DSL service; DSL and DLC applications will be discussed further under advanced services. Map 3 indicates the location of exchanges with feeder fiber deployment. Loop Fiber is defined as the distribution portion of the facility from the DSA to the customer drop wire. Graph 2 indicates there was some growth in this application as companies deploy fiber further into the customer loop.[9]

Interoffice facilities or trunks connect telephone company switches to other switches or to databases in the network. Table B indicates the number of exchanges deploying interoffice trunks and the range of percentages of DS-1 equivalent interoffice trunks that are served by fiber facilities. As the table indicates, at a significant number of exchanges, ILECs have converted 100 percent of their interoffice trunks to fiber facilities. In the past, these trunks were installed on copper cables. In many cases, when companies transfer interoffice circuits to fiber, they keep the copper cable route in place and use the route as a diverse route. This arrangement provides added security to the company's network in the event of a fiber cut or equipment failure. Map 4 indicates the location of exchanges that have deployed all, or a portion of, interoffice circuits on fiber.

Exchanges Reporting Percentage of DS-1 Equivalent Inter-office Circuits on Fiber

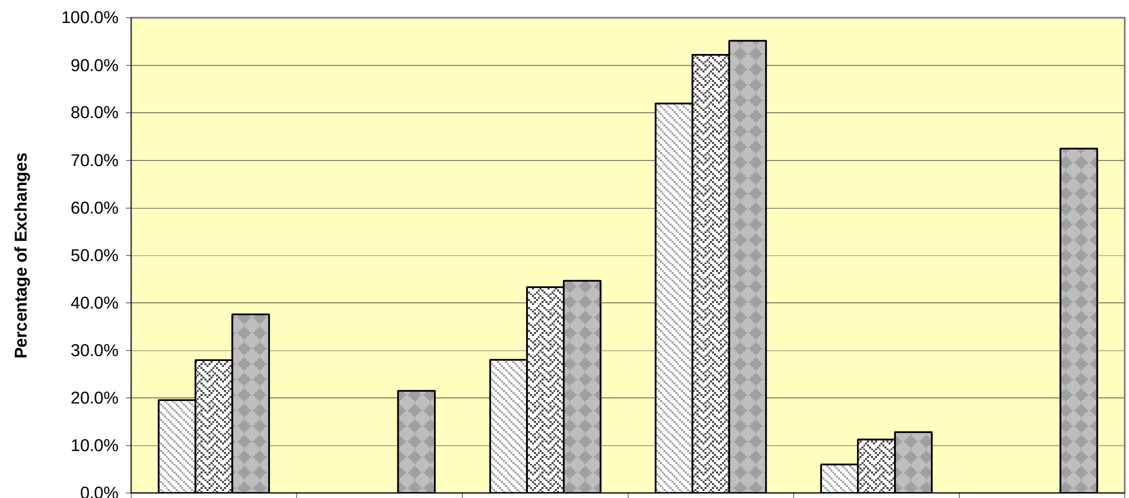
Percentage of Interoffice Trunks (DS-1 or equivalent) on Fiber	**1998** Number of Exchanges	**2000** Number of Exchanges
0%	64	41
1% to 25%	5	6
26% to 50%	11	5
51% to75%	18	11
76% to 94%	70	27
95% to 99%	60	22
100%	374	491
Total Exchanges	602	603

December 2001 Table B Source: ILEC PSC Data Requests

[9] This fiber versus copper deployment issue is not without controversy or implications for competitive providers. CLECs may need a copper facility to serve customers, but the ILEC may have only fiber in place. This can create delays in service and added cost to modify facilities.

Advanced Services. Graph 3 shows the deployment of various types of advanced services and updates earlier data and depicts the new items that companies reported for year 2000.

Advanced Services
for Incumbent Local Exchange Companies



	ISDN*	XDSL (1)	SWITCHED 56*	CALLER ID	VIDEO SERVICE*	DLC
1996	19.5%		28.0%	82.0%	6.0%	
1998	28.0%		43.3%	92.2%	11.3%	
2000	37.6%	21.5%	44.7%	95.2%	12.8%	72.5%

*Indicates Information by percentage of wire centers

(1) Percentage is based on 526 exchanges, excluding Ameritech Wisconsin

1996 1998 2000

December 2001 Graph 3 Source: ILEC PSC Annual Reports
ILEC PSC Data Requests

Integrated Services Digital Network (ISDN) is an international digital standard for voice, data, and signaling that provides more bandwidth to the consumer. The deployment of ISDN grew slightly since 1998, although in competition with ISDN service are DSL and cable modems that are becoming more common in deploying fast data delivery and faster speeds for connection to the Internet. Map 5, in the Appendix, indicates exchanges where ISDN is reported in place.

The deployment of DSL technology, a potential competitor to ISDN, is increasing steadily. DSL makes efficient use of copper wire facilities and provides a high-speed connection using special equipment, often at a lower cost than other broadband technologies such as ISDN or Switched 56 connections. DSL application is dependent on the length of the copper loop from the central office and the absence of any other equipment on the cable pair used for the DSL. There are many types of DSL offerings available, the industry uses the acronym xDSL with the “x” designating the generic type of DSL. Depending on the type of DSL, the customer’s loop length from the central office is limited to a distance of between 10,000 and 12,000 feet. Some newer varieties of DSL may extend this loop distance to beyond 12,000 feet to 18,000 feet or greater.

Fiber Feeder cable is also used to modify the customers loop distances. The feeder fiber is routed from the central office to a fiber equipment terminal located remotely from the central office. The feeder fiber interfaces with the existing copper cables at this remote terminal. In DSL applications, Digital Subscriber Line Access Multiplexer (DSLAM)[10] equipment may also be installed at the fiber terminal location. The customer's DSL loop length is then calculated from the DSLAM equipment location to the customer premise. This placement of the DSLAM equipment effectively provides shorter loop length for customers and, in that way, extends the range of the DSL service to customers.

The percentage of exchanges shown on the graph as providing DSL is calculated based on the approximately 526 ILEC exchanges. Ameritech exchanges are not included in this calculation because, in 2000, the parent company of Ameritech WI offered DSL service through a CLEC subsidiary and not through the ILEC. This arrangement is based on the SBC/Ameritech merger order of the FCC.[11] Additional CLECs also provide DSL service to customers. Map 6, in the Appendix, indicates the areas where ILECs and CLECs reported offering some type of DSL or similar broadband type service. The ILECs reported approximately 3,900 lines in use for residential DSL customers and approximately 550 lines in use for business DSL customers. This count may be somewhat underreported because not all companies who noted that DSL was in service provided actual data on lines in service.

Switched 56 is another high-speed service that offers dial-up transmission speeds of up to 56 Kilobits (Kbps) per second. Switched 56 can be used as an alternative to private line network service or as a backup to this type of service. Applications of Switched 56 include video conferencing and high-speed data transfer. Map 7 indicates the areas in which Switched 56 is available. This service meets the needs of customers requiring high–speed access on a dial-up basis. It will likely be replaced over time by faster broadband technologies.

Caller Identification (Caller ID) availability has increased. Approximately 95 percent of all exchanges now offer Caller ID. Caller ID is dependent on SS7. With Caller ID, a subscriber views the calling party's telephone number and, in some cases, the corresponding calling party's name. This feature is often used by law enforcement agencies to trace the location of incoming emergency calls. This feature also assists telecommunications providers in tracking and tracing calls. Map 8 shows the geographic location of the exchanges where Caller ID is deployed.

Video service is another advanced item for which there has been a moderate increase in deployment. Video service is defined as a video signal transmitted over telephone company provided end-to-end facilities and could include dial-up circuits or ISDN circuits. This video service does not include point-to-point video networks used for distance learning.

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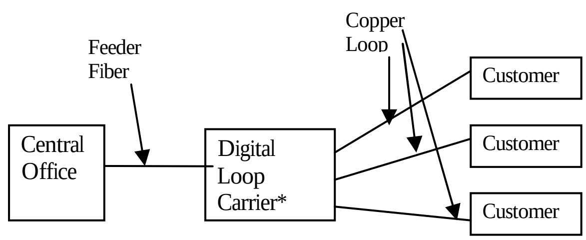
[10] The DSLAM equipment multiplexes the data signals from multiple customers and transmits them over high-speed lines back to the central office.

[11] The FCC order provided that after a set period of time, DSL could be offered by the ILEC. SBC is continuing to offer DSL through its data affiliate. Verizon returned high-speed data services to Verizon North as of December 1, 2001.

The final item shown on Graph 3 is DLC. DLC has been added to the graph for 2000 and while this is not strictly an advanced service, the companies that deploy DLC do install high bandwidth fiber optic facilities from the central office to the remote DLC terminal.

Central office equipment can normally extend a circuit up to 18,000 feet without the addition of electronic equipment. Subscribers within that range are served directly from the central office equipment. In older plant designs, customers beyond the 18,000 feet have electronic equipment installed on the individuals' copper wires to extend the central office signal. In newer plant designs, the customers beyond the 18,000 feet limit are served with DLC. The carrier equipment is installed at an intermittent point (within 18,000 feet of the central office) where there is a natural grouping of customers. Copper loops are used to route the customers back to the DLC and from that point high-speed lines carry the traffic from the carrier equipment back to the central office; in many cases, these high-speed lines are fiber. The sketch that follows provides a simple layout of a DLC design.

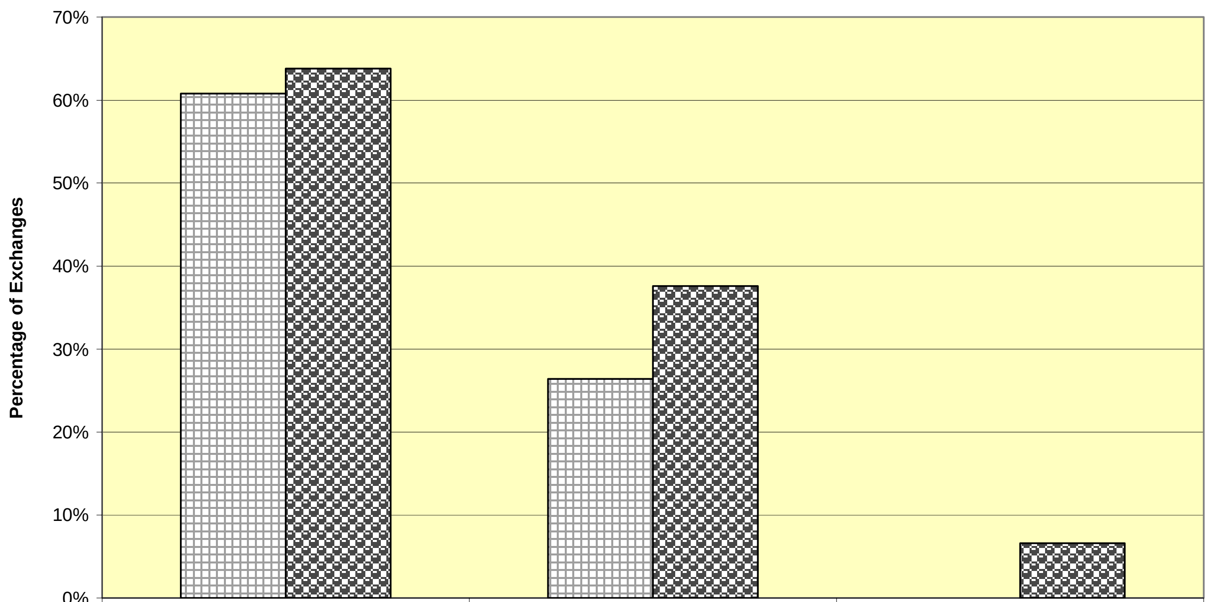


* DSLAM equipment can be co-located at this point

In some cases, providers have replaced smaller switches with DLC. Customers receive the same advanced digital service and providers achieve cost savings. The DLC can support both voice and packet data traffic. Providers reported that as of year end 2000, approximately 72 percent of all exchanges in the state had DLC in place to serve some customers. Most of this DLC traffic is carried over fiber facilities back to the central office.

Graph 4 provides information on SONET technologies and Wave Division Multiplexing (WDM) applications.

Advanced Services: Additional items for ILECs



	SONET in Place	SONET Ring in Place	WDM
1998	61%	26%	
2000	63.8%	37.6%	6.6%

1998 2000

December 2001 Graph 4 Source: ILEC PSC Data Request

Synchronous Optical NETwork (SONET) refers to a generic design standard that provides high-speed transmission over fiber optic lines. SONET organizes information electronically and can transmit different types of traffic such as voice, video, and data traffic simultaneously. SONET can be deployed in a number of different types of architecture to aggregate traffic and provide this high-speed transmission. The ring type architecture increases reliability by providing redundancy; however, the ring design also increases the cost of the system. To save on system costs, companies may initially install point-to-point SONET facilities and install the ring architecture over time. Some advantages of SONET are cost effectiveness and flexibility in the network and the ability to interconnect network equipment from different vendors. Map 9 indicates the location of exchanges where SONET facilities have been deployed.

Wave Division Multiplexing (WDM) provides for increased data carrying capacity on fiber optic lines by operating at multiple wavelengths. The advantage of WDM is that it can increase network capacity without having to deploy additional fiber. This not only saves costs but allows increased capacity where adding fiber is not feasible. It is anticipated that WDM will continue to be deployed on existing fiber optic systems.

The final item reviewed for this report is 911 availability. This service refers to the emergency reporting system where a caller can dial one number (911) for emergency services. In Wisconsin, 911 is often county-funded and implemented under a contract between the county and the telephone companies serving that county. Map 10 shows the status of 911 availability as of January 2002. The emergency 911 service is not mandatory in Wisconsin; it is a local government and law enforcement decision whether to install 911 in a particular location.

Capital Expenditures. Table C indicates the annual capital investments made by the ILECs from 1992 through 2000. These expenditures cover all the types of infrastructure deployment discussed above.

Total ILEC Plant Additions		
Year	Plant Additions in Dollars	Change From Previous Year
2000	$559,306,926	7.12%
1999	$519,487,322	16.24%
1998	$446,899,834	19.36%
1997	$374,403,187	-4.26%
1996	$391,080,104	10.13%
1995	$355,114,857	20.18%
1994	$295,488,914	-6.07%
1993	$314,575,622	3.70%
1992	$303,348,717	

December, 2001 Table C Source: ILEC PSC Annual Reports

Competitive Local Exchange Carrier Facilities

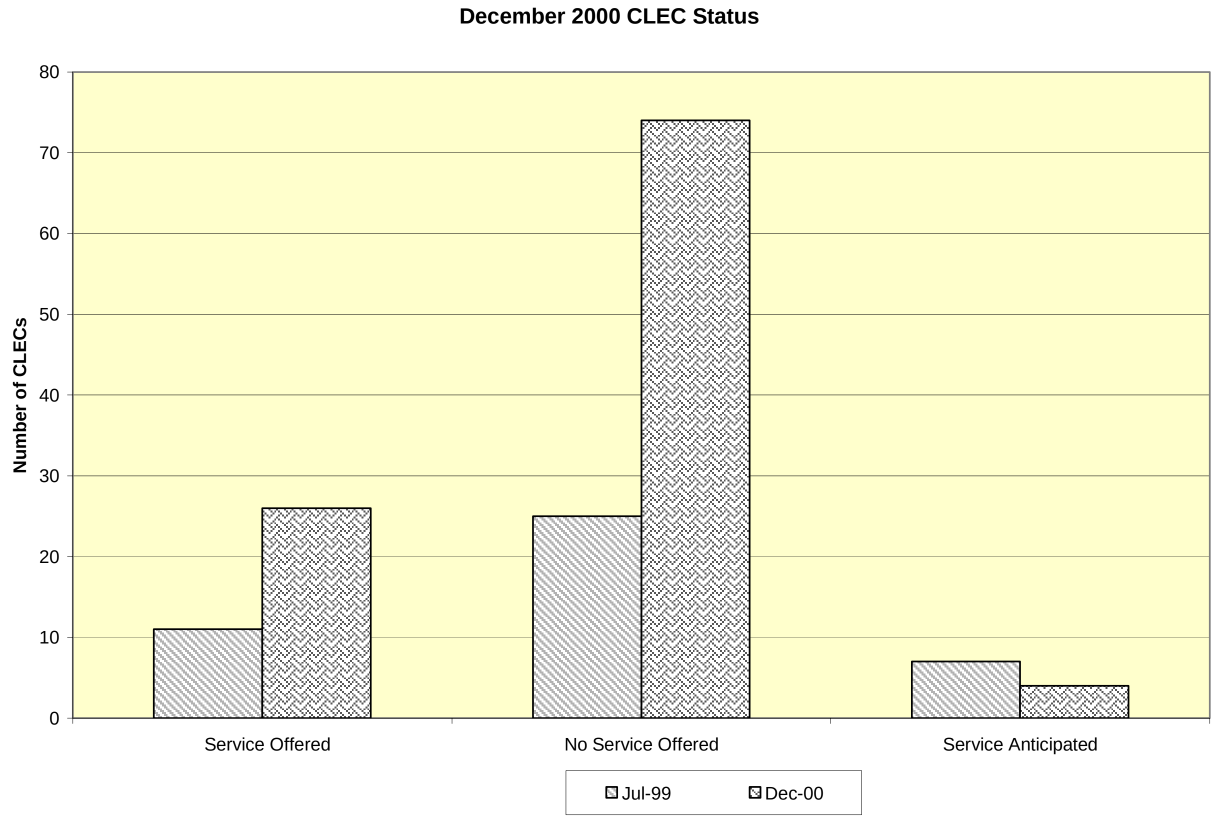
Among the goals of 1993 Wisconsin Act 496 and the Federal Telecommunications Act of 1996 was the spurring of competition in the telecommunications industry. Competition in various markets continues to evolve.

The Commission established a Competitive Study Committee to examine various issues on the status of competition in the state. That Committee collected information through a data request from all types of competitive carriers including cable and wireless providers. Further information on competitive carriers, including CLECs, will be published in a report of the Committee under docket 05-ST-109.

In Wisconsin, CLECs provide services in competition with the traditional ILECs. As of December 2001, 126 CLECs were certified to provide service in Wisconsin. This is up from 50 CLECs as reported for 1999. Although over 100 CLECs in Wisconsin were certified to provide service at year end 2000, under one quarter of those certified were actually providing service to customers.

The past 18 months have been tumultuous for the CLECs. The CLEC industry is undergoing a major industry shakeout, and this is expected to continue through 2002. Reports indicate that the number of CLECs with financial troubles has grown, and many CLECs have scaled back on staff and infrastructure investments. A number of CLECs have declared bankruptcy and are in the process of reorganizing; others have merged with larger companies and sold off portions of their businesses.

The information and maps on CLEC operations presented in this report reflect year end 2000 status as reported to the Commission. Filed data indicates that 25 CLECs offered some type of service at year-end 2000. Graph 5 shows the status of CLECs that responded to the Public Service Commission (PSC) data request.

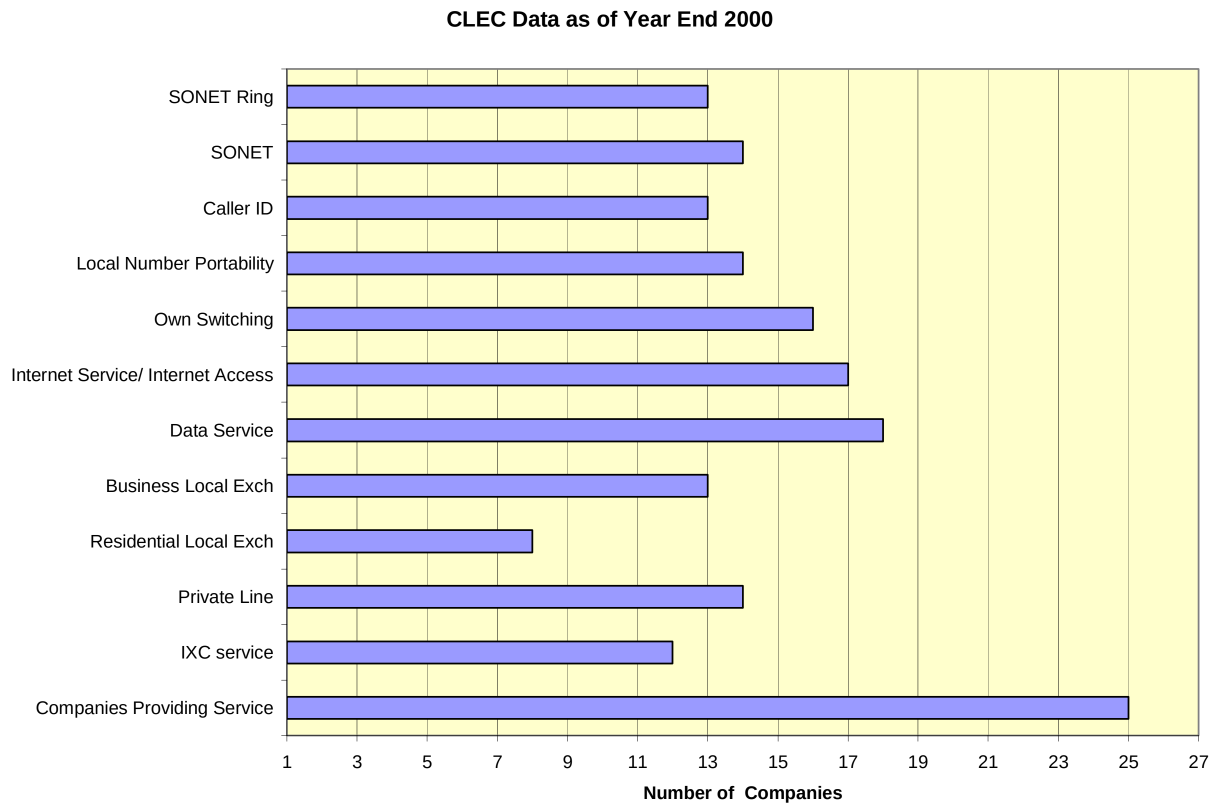


December 2001 Graph 5 Source: CLEC PSC Data Request

Map 11, in the Appendix, indicates the areas where the CLECs offered service in ILEC exchanges at the end of year 2000. Larger cities such as Milwaukee, Madison, Green Bay, Kenosha, Racine, and communities surrounding Milwaukee, such as Waukesha, are served by multiple providers.[12]

Graph 6 shows the number of CLECs that are providing particular items or services and the types of services offered. CLECs may not provide the same service offerings in all of the geographic areas they serve. For purposes of the presentation in Graph 6, a CLEC is counted as offering an identified service if it offers it anywhere within its serving areas. The graph shows that the majority of the CLECs have their own switching facilities and most offer some type of data service. Any particular CLEC may be offering one, some or all of the services listed on the graph.

[12] These providers may serve only a portion of the area and often offer selective services such as data or interexchange carrier (IXC) access service only. Some also may only serve a single classification of customers (e.g., business) or at least only actively market to the segment of customers.



December 2001 Graph 6 Source: CLEC PSC Data Request

A majority of the CLECs provide high-speed connections to the Internet. While this connection can be offered in a number of ways such as ISDN or T-1 connections, DSL service is the fastest growing type of service for the landline based carriers. Map 6, in the Appendix, indicates locations where ILEC and CLEC providers reported DSL as a service offering.[13]

CLECs report information to the Commission in an annual report. These annual reports indicated that CLECs added approximately $82 million to their infrastructure in 2000. Actual infrastructure additions may exceed this level because not all companies reported the data correctly, and some noted they did not have the information in the format requested in the annual report.

[13] This CLEC information was compiled using the information filed in response to the infrastructure data request and the competitive study request. There are instances where the two data filings were not in agreement. Commission staff reviewed the responses and mapped the CLEC data as accurately as possible.

Wireless and Cable Providers

High-speed access to the Internet is in high demand by consumers. Cable television providers, DSL providers, and wireless service providers are increasingly competing to serve these broadband service customers.

Broadband service is not simply an offering aimed at enhancing access to the Internet. A fast connection and transmission speed make other applications possible and more efficient. These include video conferencing, gaming, and video on demand. Internet Protocol (IP) voice telephony is in the early stages of deployment. Some believe that such technology may eventually replace analog telephone service. A recent report in Electronic Design[14] indicated that 6.45 million cable-modem subscribers were in place in the United States as of mid-2001. DSL is second with 2.92 million subscribers and mobile wireless service, with a broadband connection, has several hundred thousand subscribers. High-speed connection to the Internet is predicted to continue to be a growth driver. Industry analysts forecast that by 2005, 30 million households will have a broadband connection.

The majority of residential subscribers in Wisconsin already have their homes wired for cable television. This gives cable providers an advantage in providing broadband service in this market. Often newer computers can be ordered with cable-ready modems in place. Another reason for cable's success in entering the high-speed access business may be the price of installation to the consumer. Anecdotal evidence indicates that cable broadband installations are often free with a cable TV hookup and that the monthly fee for this service is comparable to DSL service. On the other hand, consumers have reported fees for DSL installations of up to $500. Cable modem speeds typically range from 3-50 Mbit/s. In a test of a download of a 1 Mbit file, the cable modem downloaded the file in seven seconds, an asymmetric digital subscriber line (ADSL) connection downloaded the file in 32 seconds, and a 28.8K/s connection downloaded the file in 277 seconds. One disadvantage of cable modem connections is the sharing of bandwidth with multiple customers in an area. This sharing may result in slower connections as more users come on line. DSL users on the other hand, essentially have guaranteed speed once connected to a phone line broadband network.

Businesses are less likely to be wired for cable; however, cable companies are making inroads by providing cabling for special access connections for high-speed data transmission. New products, such as one providing a dedicated 40 Mbit/s symmetrical connection, will make cable a reasonable alternative to provide broadband access for businesses.

Another option for broadband users is a wireless connection. In most cases, the local loop uses copper twisted wires to provide service to the customer's door. Fixed Wireless Local Loop (WLL) is a wireless system that replaces the twisted copper connection with a digital radio signal. A pair of rooftop transmitters are installed, one at the central office and one at the customer's offices. This provides a digital wireless transmission path that allows carriers to provide connections up to T-1 (1.5Mb/s) capacity. Wireless technology is continuing to improve and evolve and it is becoming more cost effective to do wireless networking in offices or homes. The advantages of this technology are rapid deployment and

[14] Electronic Design, July 23, 2001, Louis E. Frenzel.

configuration, because it avoids the cost of buying and installing wires and cables. WLL may be cost effective for providers who need to quickly deploy local loop facilities. Wireless packet switched networks are designed specifically for data communications.

Cell phone users can purchase a service that provides unlimited characters in e-mail messages received over their cell phones. Users of this network can typically send messages anywhere in the network for the same rate per message. Home wireless installations also have potential for growth. In a typical wireless system installation to a home, a digital switching center would be connected to a neighborhood antenna that could serve up to 2000 homes and could be mounted on a utility pole or other structure. The wireless customer would install a fixed transceiver to the house to complete the installation.

An increasing number of Internet capable phones are being deployed and some projections of Internet usage note that the wireless clients will outnumber their wired counterparts in the next few years. Although wireless technology is handicapped somewhat by limited bandwidth, there still is opportunity for the high-speed wireless technologies. Many forms of wireless technologies are increasingly becoming contenders for high-speed access customers.

Broadband Personal Communication Service (PCS) includes many types of technologies and is a high-frequency alternative to traditional wireless service. Recently, the FCC issued a further notice of proposed rule making seeking to modify rules to allow license-free use of ultra wideband (UWB) transmitters.[15] This technology has been under development for a number of years. Although it is strongly opposed by the cell phone companies who believe it will cause interference with their transmissions, developers of the technology believe that UWB has great potential for high-speed wireless communications with the proper architecture of the system.

With consumers' interest in faster connections for Internet, video conferencing, and gaming, both cable modems and wireless services have the potential to be viable competitors to wire line broadband service offered by facilities-based companies.

[15] Docket No. ET 99-231, Action by the Commission, May 10, 2001, by Further Notice of Proposed Rule Making and Order (FCC 01-158).

Part

4

Recommendations and Conclusions

Infrastructure

The information the Commission has on file indicates that steady progress in infrastructure investments is being made by the ILECs as evidenced by continued deployment of SS7, DSL, and fiber facilities. The ILECs further commit to infrastructure additions under price cap regulation and alternative regulation. Map 12, in the Appendix, provides locations of the exchanges that are under price regulation and alternative regulation. These types of regulation plans provide an appropriate level of consumer protection while giving the companies control over the type of infrastructure and technology they deploy for their serving areas. The plans also give the Commission information on the infrastructure deployment plans for areas of the state. It is important that infrastructure continue to be maintained and deployed to provide customers with the security of a dependable telecommunications systems and the availability of advanced features for service when they are requested.

Broadband Deployment

The future for broadband is one that encompasses many aspects of communications including data, voice, and video. Records show broadband services have been deployed by both the ILECs and CLECs. In most cases, broadband deployment is an economic, not a technical, issue for providers. Each of these companies will determine what technologies will generate the profits they need to continue, as well as provide customers with high-speed access at a reasonable monthly rate. No one technology is recommended for deployment; the marketplace should be allowed to sort out the technologies that will supply this connection. Some assistance for broadband deployment is being discussed on the federal level. On a state level, it is recommended that broadband deployment continue to be monitored, and broadband service additions continue to be included as an incentive in ILEC alternative regulation plan filings.

Reporting of Information

With respect to infrastructure monitoring, recommendations include:

- The continuation of ILEC information reporting through annual reports and data requests;

- The standardization of CLEC reporting formats and a continued and emphasized requirement for the reporting information through the annual report and data requests;

- The provision of statutory authority under Wis. Stat. §196.25 so the Commission may collect information through data requests from cable TV and wireless providers.

The ILECs have a standard format for reporting and, in general, the information on file is accurate and up-to-date. The standard reporting format allows for comparison of services and investments in infrastructure. This type of reporting should be continued to provide data to substantiate the progress in infrastructure deployment.

The CLECs have much less up-to-date information on file, and therefore analysis is less conclusive as to the infrastructure these CLECs have in place and the type of services they offer. Part of this problem with recently filed information is the result of the economic shakeout in the industry. Both investments and personnel are being cut as CLECs adjust to the present situation. Once the economic situation stabilizes, companies should be able to provide information on current investments and definite plans for growth and future investments. There still remains a problem with differences in how the information is reported and the formats companies use to compile and report information. As noted above, it is difficult to make a comparison of data when infrastructure information is reported in a different manner by each company. For example, areas served by CLECs are reported in a number of ways; some service areas are reported by communities' served, others are reported by the switch Common Language Location Identifier (CLLI) codes for a wire center, and some areas service are reported by zip code. In many cases, access lines were not reported by area served, but rather in total for the company. These types of inconsistencies make it difficult to prepare an entire picture of the CLEC participation in the state. Further work by the Competitive Study Committee could assist in establishing a standard format for collecting data and reporting data by the competitive providers.

Cable TV and wireless providers have cooperated with the Commission through the Competitive Study Committee and supplied some of the information requested, but their cooperation is strictly voluntary. It is recommended that Wis. Stat. § 196.25, that requires utilities to respond to Commission questionnaires, be amended to include cable TV and wireless companies. Under this statute, utilities are required to respond to questionnaires, provide maps, provide additional property information, and submit data within a specific time period. It is also recommended that the Commission have the ability to impose penalties or other consequences on companies that fail to respond to data requests or that file reports without providing the information as requested. This important legislative action will assure that future questionnaires are answered fully and completely by all providers and that the information on telecommunications infrastructure is provided to assure an accurate evaluation of the status of infrastructure investments in the state.

Confidentiality

The data request responses received from providers were, for the most part, filed on a non-confidential basis. All ILEC responses were filed publicly, and only a small number of competitive providers filed information confidentially. The Commission is authorized under Wis. Stat. § 196.14 to withhold from public inspection any information deemed to aid competitors of a public utility. The Commission determines whether to withhold information on a case-by-case analysis of the competitive or sensitive nature of the information filed.

While the Commission acknowledges that competitive companies may logically file market share information with the Commission on a confidential basis, the Commission encourages that other information, on the areas where service is provided and the type of services offered, be filed and available as public information. This type of information is particularly necessary to aid in providing a complete picture of competition in the state and to provide necessary information to legislators and customers regarding service offerings status and availability of competitive services in the state.

Conclusions

In its recommendations for documenting the progress of investments in advanced telecommunications infrastructure in the state, the Commission continues to use 1993 Wisconsin Act 496 principles as the basis for its recommendations. That is, that the marketplace is allowed to determine what services companies offer and what companies will offer that service.

As competition expands in the state and as more providers enter various markets, the mere presence of additional providers, coupled with their responsiveness to customer demands, will logically lead to further infrastructure investments. Likewise, those same market forces, along with concurrent industry innovations in service provisioning, will likely spawn enhancements to existing technologies and the emergence of new technologies not commercially available today. Consequently, the Commission will not only monitor and update the infrastructure components already tracked in this and earlier reports, but will also update future reports to reflect changes in technology that evolve to fulfill the needs of the telecommunications marketplace.

While market dynamics will be a critical factor in infrastructure growth and enhancement, it is apparent from a review of the existing status of deployment for several technologies and services, that there remains room for improvement and expansion. To that purpose, the Commission will continue to stress infrastructure improvements as a key element of alternative regulation plans and will also explore infrastructure issues in those other proceedings (e.g., rate increase dockets) where that issue is relevant.

Part

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Appendix

REFERENCE MAPS

A...........County Boundaries
B...........Telephone Exchange Boundaries

INFRASTRUCTURE MAPS

1............Incumbent Local Exchange Carrier (ILEC) Packet Switch Availability
2............ILEC SS7 Availability
3............ILEC Feeder Fiber Location
4............ILEC Inter-office Circuits on Fiber
5............ILEC ISDN Availability
6............ILEC and CLEC DSL Availability
7............ILEC Switched 56 Availability
8............ILEC Caller ID Availability
9............ILEC SONET Facilities Availability
10 ....Wisconsin 911 Availability 2001
11 ....Competitive Local Exchange Carrier (CLEC) Service Locations
12……ILEC Regulation

Acronyms

Part
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A

ADSL - asymmetric digital subscriber line · 20

C

Caller ID - Caller Identification · 13
CESA - Cooperative Educational Services Agency · 4
CLECs - Competitive Local Exchange Carriers · v
CLLI - Common Language Location Identifier · 24
CODECs - Compressor Decompressors · vi
Commission - Public Service Commission · v
CT - Cat Scan · 5

D

DEG - The Wisconsin Department Electronic Government · vi
DLC - Digital Loop Carrier · 9
DOC - The Wisconsin Department of Corrections · vi
DSA - Digital Serving Area · 11
DSL - Digital subscriber line · v

F

FCC - Federal Communications Commission · v

G

GIS - Geographic Information Systems · *i*

I

ILECs - Incumbent Local Exchange Carriers · v
IP - Information Providers · 20
ISDN - Integrated Services Digital Network · i

P

PCS - Personal Communication Service · 21
PSC - Public Service Commission · 17

S

SONET - Synchronous Optical NETwork · vi, 15
SS7 - Signaling System Seven · 9
Switched 56 - up to 56 Kilobits (Kbps) per second · 13

T

TEACH - Technology for Educational Achievement in Wisconsin · v

V

VA - Veterans Administration · vi

W

WDM - Wave Division Multiplexing · 14, 15
WLL - Fixed Wireless Local Loop · 20

X

xDSL - Generic Digital Subscriber Line · v